[0026] Modern personal electronic devices, including wireless communication devices, are more and more used to watch and listen to multimedia such as music and movies. Such devices are frequently used with headsets or headphones, but they are also usually provided with an internal loudspeaker. However, small devices have only small spaces available for a loudspeaker, and the space available for a loudspeaker and other components is shrinking, or at least not growing, as devices continue to shrink. Small loudspeakers tend to provide unsatisfactory listening experiences because they tend to provide unsatisfactory low-frequency responses. For a moving coil loudspeaker, the low-frequency limit is reduced, and the sensitivity is increased, as the rear volume of an acoustic back cavity increases. The rear cavity has an associated air compressibility, which increases with the rear cavity volume and decreases with the area of the speaker cone compressing the air. With a larger speaker cone area, or a smaller rear cavity, the air is less compressible so that increased force is needed to compress it. The fundamental resonance of a speaker system depends on the mass of the driver, and the combination of the incompressibility of the air in the rear cavity and the stiffness of the suspension of the cone. These factors combine to increase the fundamental frequency as the rear cavity volume becomes smaller. Similar principles are applicable to other loudspeaker designs, such as piezo and electrostatic loudspeakers.

[0027] Incorporating a large rear cavity into a speaker design that is to be used in a portable electronic device is difficult as devices are tending to become smaller and thinner, with smaller transducers being used in speakers and with accompanying degradation in performance. However, with use of the airflow spreader **38** additional distributed spaces with the apparatus **10** may be used to provide an effectively larger acoustic back cavity system.

[0028] Referring also to FIGS. **4** and **5**, the cover **36** has the speaker **34** mounted thereon. FIG. **5** is a schematic illustration of the cover **36**. The cover **36** forms an acoustic back cavity **48** for the speaker **34**. The cover **36** also has a plurality of other second cavities **50** at spaced locations around the cover **36**. These cavities **50** are illustrated by circled areas in FIG. **4**. These cavities **50** are substantially empty; perhaps with internal walls **52** for structural rigidity of the cover **36**. One or more of the cavities **50** might have some of the electronic circuitry of the PWB(s) **28** extending thereinto. However, when the airflow spreader **38** is connected to the cover **36**, the cavities **48** and **50** are substantially sealed or closed except through a conduit system formed by the airflow spreader **38**. The term “connected” should be considered the same as “coupled” or “attached”.

[0029] As described above with reference to FIG. **3**, the airflow spreader **38** has holes **46**. When the airflow spreader is connected to the cover **36**, the airflow spreader **38** substantially closes the cavities **48**, **50** with the holes **46** being aligned with the cavities **48**, **50** to couple the cavities with the main chamber **44**. Thus, as illustrated by FIGS. **6** and **7**, the airflow spreader **38** forms a conduit system to interconnect all the cavities **48**, **50** together.

[0030] The simplest way to extend low frequency playback of an acoustic system is to enlarge the back cavity volume. Features as described herein may be used to maximize use of otherwise unused space inside the apparatus **10** as the back cavity volume for the speaker, and to keep the apparatus as a slim design as well. A normal way for a speaker system to be designed is to leave a maximum part of the phone as an acoustic back cavity. However, sometimes, even with designing in a maximum part for the speaker back cavity, the space is still not enough because of the limited dimensions of the apparatus housing. With features as described herein, spaces in the apparatus may be utilized to effectively increase an area for low frequency sound; thus extending the low frequency of sound from the speaker. This advantage is particularly helpful in full touch screen mobile phones, for example, where emplty interior space is very limited.

[0031] The speaker may be assembled in the bottom of the phone to share the volume of an antenna to get the biggest back cavity volume. By additionally using other space in combination with the normal acoustic back cavity for an enlarged effective acoustic back cavity system, the back cavity volume may be increased, such as doubled for example. Low frequency capability may be increased by lowering the low frequency range (see **82** in FIG. **8** versus **80** in FIG. **8**). To utilize the spaces that are not usually used for an acoustic back cavity, a new mechanical solution is provided. The biggest difficulty for utilizing the cavities **50** is that the unused spaces are distributed all over the cover **36** and would otherwise be hard to be connected.

[0032] One example of the mechanical solution may comprise a cover **36** which will hold the speaker and has a one basic cavity **48**. There are several distributed spaces **50** that may be used as additional cavities. There is no limitation to each distributed cavity’s size or shape. The “airflow spreader” may cover all the selected distributed cavities. In one example the “spreader” may be two panels (or other similar members) with a certain gap to form the air chamber **44**, but well sealed all around. In a mobile phone design, this “spreader” can use the PWB and UI frame by adding a gasket **54** in between. On the panel that covers the cover **36**, holes **46** may be provided for each of the corresponding main and distributed cavities **48**, **50** with proper pre-determined designed diameters. Airflow can reach to every single distributed cavity **50** through the holes **46** and the chamber **44** of the spreader. The spreader may be designed inside a main PWB, a phone cover, a chassis, and/or formed via other parts providing substantially sealed acoustic paths.

[0033] Acoustic simulation for a single 0.8 cc back cavity **48** and a **3** cc distributed speaker cavities design is shown in FIG. **8**. As seen in this chart, the combined multi-cavity design **82** can provide a lower frequency response than the single cavity design **80**. There is some harmful resonance in the mid-frequency. However, as illustrated by FIG. **9**, this can be conquered by adding damping material at the holes of the speaker or main cavity as shown by **82'**.

[0034] The example described above comprises an airflow spreader with a single air chamber **44** connecting the holes **46** for the cavities **50** to the hole **46** of the main back cavity **48**. However, the airflow spreader may comprise more than one internal air chamber. Referring also to FIG. **10**, in this example the cover **36** has the airflow spreader **38'** attached. The spreader has two conduits **44***a*, **44***b* from the main acoustic back cavity **48** to the holes **46** of the additional cavities **50**. The conduits **44***a*, **44***b* may be formed in a PWB. Circuitry may be re-designed around the conduits, and/or the conduits may have designed paths around circuitry on the PWB. In another example the cover **36** may form part of the conduits **44**.

[0035] In accordance with one example embodiment, an apparatus **10** comprises a housing member **36** includes an acoustic back cavity **48** for a sound transducer **34** and at least